River Ice Delineation with RADARSAT SAR

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The use of satellite imagery to identify and delineate river ice is influenced by the spatial resolution and electromagnetic properties of the sensor, climatic conditions, and river channel geometry. This project expands previous research applications of LANDSAT, AIRSAR, and ERS-1 imagery to delineate river ice by utilizing RADARSAT Fine Beam Mode SAR imagery. RADARSAT data were acquired at three sites in the winter of 2002 and the winter of 2003: the Mississippi River at Mel Price Lock and Dam to identify the extent of ice in a navigable waterway; the Missouri River at Bismarck, ND, to identify ice conditions downstream of a hydropower dam; and the Red Lake River near Grand Forks, ND, where an extended ice jam flood record exists. These sites provided a range of conditions suitable for RADARSAT imagery to detect river ice. The widths varied from 1500 meters for the Mississippi River; 600 meters for the Missouri River, to 60 meters for the Red Lake River. The RADARSAT Fine Beam imagery at 10-meter resolution was able to identify ice in all six images, and open water in three images. Remote cameras or direct ice survey provided ground truth to identify the existence of ice and support the delineation of ice with RADARSAT data.

In this project, we acquired six RADARSAT images of three sites in the winters of 2002 and 2003 to explore the suitability of using RADARSAT data to detect river ice conditions. The three sites we selected varied in river widths and ice conditions.
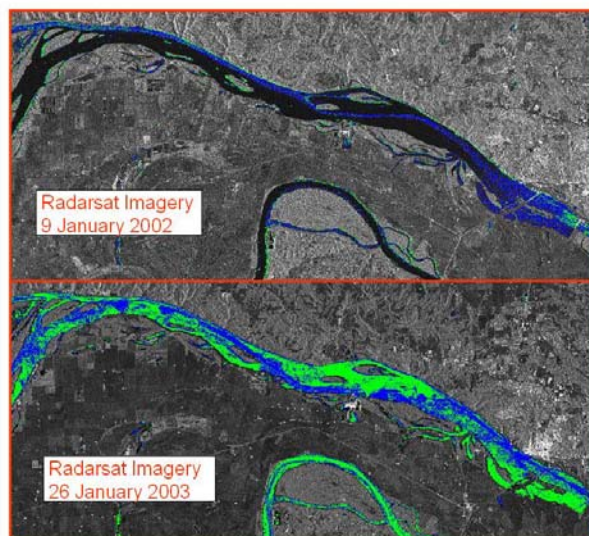
Radarsat Fine beam imagery was used to identify, and then delineate river ice. In these images of the Mississippi River at St. Louis, Missouri, the color mask is identifying the location of ice in the channel; blue = brash ice, or recently broken-up ice, and green = solid ice cover.

In the Mississippi River imagery near St. Louis, Missouri, the wide channel width (500-2000 meters) contributed to identifying river ice with RADARSAT imagery. In the 2002 image it was determined that 30% of the channel had ice in the flow, and in the 2003 image, it was determined that there was 100% ice cover. Additionally, this ice cover was separated into forms of ice; brash ice and border ice. In the 2003 image it is believed that the brash ice formed as a result of navigation ice-breaking activities.
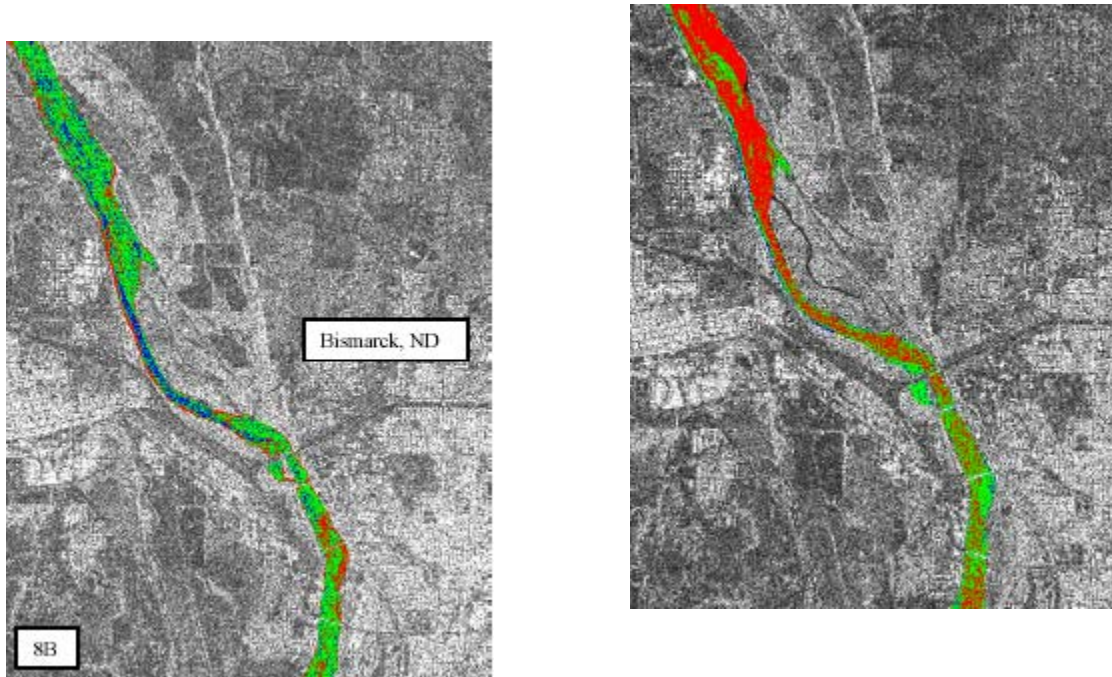
Subscenes of RADARSAT image acquired on February 5, 2002 (1800 local time) and January 7, 2003 (1843 local time) at Bismarck, ND. The patterns detected indicate open water leads (red), ice cover/wet ice (green), and rough ice (blue) in the channel.

In the Missouri River imagery near Bismarck, ND, the channel width (400-1000 meters) was suitable to delineate, and river ice was determined from the RADARSAT imagery. In the 2002 image it was determined that 77% of the channel had ice in the flow, and in the 2003 image, only 21% of the channel had ice. The imagery acquired in 2003 was prior to full icing conditions, and a small amount of ice was interpreted to exist.

RADARSAT imagery of Red Lake River at confluence with Red River of the North, Grand Forks, ND. The image on left is from winter 2002, and the image on right is from winter 2003.

In the Red Lake River imagery near the confluence with the Red River of the North at Grand Forks, ND, the river channel is narrow (40-75 meters). The narrowness of the channel limited the process of delineating the channel boundary on the imagery. As a result of the narrow channel width, river ice was not determined by this process. However, ice surveys were conducted by the US Army Corps of Engineers during the time of image acquisitions, and an ice cover was recorded in both 2002 and 2003.